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Displacement risk and asset returns ☆

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ABSTRACT

We study asset-pricing implications of innovation in a general-equilibrium overlapping-generations economy. Innovation increases the competitive pressure on existing firms and workers, reducing the profits of existing firms and eroding the human capital of older workers. Due to the lack of inter-generational risk sharing, innovation creates a systematic risk factor, which we call "displacement risk." This risk helps explain several empirical patterns, including the existence of the growth-value factor in returns, the value premium, and the high equity premium. We assess the magnitude of displacement risk using estimates of inter-cohort consumption differences across households and find support for the model.

1. Introduction

In this paper we explore asset-pricing implications of innovation. We concentrate on two effects of innovation. First, while innovation expands the productive capacity of the economy, it increases competitive pressure on existing firms and workers, reducing profits of existing firms and eroding the human capital of older workers. Thus, innovation creates a risk factor, which we call the "displacement risk factor." Second, since economic rents from innovation are captured largely by the future cohorts of inventors through the firms they create, existing agents cannot use financial markets to avoid the negative effects of displacement. Innovation risks cannot be perfectly

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shared even if a complete menu of state-contingent claims is available for trading, since the future innovators, who are yet to enter the economy, are not able to trade with the current population of agents.

We capture the displacement effect in an overlapping-generations general-equilibrium economy. We model production with multiple intermediate goods that are used to produce a single consumption good. Innovation creates a stochastically expanding variety of intermediate goods. Intermediate goods are partial substitutes; therefore, growth in their variety intensifies competition between their producers and leads to displacement of the established firms by the new entrants. In addition, older workers are not as well adapted to the new technologies as the new cohorts of agents, which implies that innovation diminishes older workers' human capital. Thus, there are two sides to innovation. The bright side is the increased productivity it brings, which raises aggregate output, consumption, and wages. The dark side is the reduced wage-bill and consumption shares of the older agents.

The displacement risk faced by older agents is a systematic risk factor, and distinct from aggregate-consumption risk. Individual Euler equations in our model cannot be aggregated into a pricing model based solely on aggregate consumption because of the wedge between the future consumption of all agents *present currently* and the future *aggregate* consumption: the latter includes the consumption of future cohorts, but the former does not. This wedge is stochastic and driven by innovation shocks. Thus, the standard aggregate-consumption-based pricing model must be augmented with the displacement risk factor. This argument helps explain several important empirical patterns in asset returns.

First, the displacement risk factor is connected to cross-sectional differences in stock returns. We assume that existing firms participate in innovation, but some firms are more likely to innovate than others. The more innovative firms derive a larger fraction of their value from future inventions and earn higher valuation ratios, which makes them "growth firms." Because of their relatively high exposure to the innovation shocks, growth firms offer a hedge against displacement risk and, in equilibrium, earn lower average returns than less innovative "value firms." Thus, heterogeneous exposure to displacement risk helps explain the positive average return premium earned by value stocks relative to growth stocks, called the value premium. Moreover, innovation shocks generate co-movement among value stocks and among growth stocks, giving rise to a value-growth factor in stock returns. Hence, our model rationalizes the empirical success of a multifactor model featuring a value-growth factor, documented by Fama and French (1993).

Second, the aggregate equity premium in our model is boosted by the stock-market exposure to the displacement risk factor. Large innovation shocks simultaneously lower the value of existing firms through increased competition and reduce consumption of existing agents through the erosion of their human and financial wealths. As a result, agents require a higher premium to hold stocks than could be inferred from the aggregate consumption series using standard pricing models.

Third, the equilibrium interest rate in our model is lower than suggested by the aggregate consumption process and agents' preferences. This is because individual agents' consumption growth is lower, on average, and riskier than that of aggregate consumption. This property of overlapping-generation economies is noted in the seminal paper of Blanchard (1985) and emphasized recently in an asset-pricing context by Gârleanu and Panageas (2007). Allowing for some degree of "catching up with the Joneses," as in Abel (1990), magnifies the size of this effect.

Our model also has implications for the cointegration properties of (a) the dividends paid by all corporations that current agents can trade and (b) the dividends paid by all firms at any point in time t, which we refer to as "aggregate" dividends. The latter are cointegrated with (in fact, a constant fraction of) aggregate consumption. However, the former are not, since the future share of aggregate output accruing to the firms existing currently declines towards zero asymptotically due to innovation. The lack of cointegration is empirically realistic and has been recently recognized in the literature as quantitatively important for understanding aggregate market returns.

We test the implications of our model empirically. We identify innovation shocks through their effect on the consumption of individual cohorts and show that intergenerational differences in consumption correlate with the return differences between value and growth stocks. In addition to the empirical tests, we use the empirical moments to calibrate our model and verify that its mechanism can reproduce key asset-pricing patterns quantitatively.

Our paper relates to several strands of the literature. A number of papers use an overlapping-generations framework to study asset-pricing phenomena, e.g., Abel (2003), Constantinides, Donaldson, and Mehra (2002), Geanakoplos, Magill, and Quinzii (2004), DeMarzo, Kaniel, and Kremer (2004, 2008), Gârleanu and Panageas (2007), Gomes and Michaelides (2008), or Storesletten, Telmer, and Yaron (2007). None of these papers, however, considers the displacement risk, which lies at the core of all our results. Our model of innovation is similar to Romer (1990), who studies endogenous sources of growth in a deterministic setting. We treat growth as exogenous and instead focus on the impact of stochastic innovation on financial-asset returns. Consistent with the premise of our model, Hobijn and Jovanovic (2001) show the permanent negative impact of innovation on incumbent firms in the context of the information-technology (IT) revolution. However, they employ a representative-agent framework and hence do not consider the displacement risk of innovation across agents.

Our paper also contributes to the theoretical literature on cross-sectional patterns in stock returns, which includes Berk, Green, and Naik (1999), Gala (2005), Gomes, Kogan, and Zhang (2003), Carlson, Fisher, and Giammarino (2004), Papanikolaou (2007), and Zhang (2005), among many. Our contribution is the new